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SCH4U – Chemical Bonding & Lewis Structures Handout

A. Chemical Bonds

What is a chemical bond?

There are 3 different types of molecules that can form as a result of chemical bonding: **molecular elements, molecular compounds** and **ionic compounds**.

Define the following:

1. Molecular Element:

Example(s):_____

2. Molecular Compound

Example(s):_____

3. Ionic Compound

Example(s): _____

B. Ionic Bonds & Ionic Compounds

- Ionic Bond definition:

- Ionic compounds typically form between what type of elements?

- When many positively and negatively charged ions come together they can form large structures such as:

- A formula unit represents:

C. Covalent Bonding - Molecular Elements & Compounds

- Atoms in molecular elements and compounds are held together by:

- Covalent bond definition:

- Covalent bonds typically form between what type of elements:

- List some of the reasons that chemical bonds form:
    -
    -
    -
    -
    -

- Valence electron definition:

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- Use numbering and arrows to indicate the number of valence electrons in the elements of the columns of the periodic table below:

1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.581538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6534	29 Cu 63.545	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.504	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 196.56655	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.94.79	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.56655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.58038	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (289) (287)		116 (289)		118 (293)

58 Ce 140.116	59 Pr 140.50765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04	71 Lu 174.967
90 Th 232.0381	91 Pa 231.035888	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

D. Lewis Theory of Bonding:

- Atoms and ions are most stable if they have:
- Electrons are most stable when they are:
- Atoms form chemical bonds to achieve:
- Full valence shells can be achieved by exchanging electrons between:
- Full valence shells can also be achieved by sharing electrons between:
- In Lewis structures, dots represent_____ and lines represent_____ in which pairs of electrons are_____.

- **Duet rule definition** (H and He):

- Why does helium tend not to bond with other atoms?

In a chemical bond, shared electrons "count" for both atoms that are sharing them in terms of filling the valence shell.

- **Octet rule definition:**

- When atoms have 8 electrons in their valence shell, this is known as a:

- Draw the Lewis structure of F_2, indicating how each atom is able to form a stable octet by sharing electrons:

- Define bonding capacity:

What is the bonding capacity of the following atoms?:

- Carbon (C):
- Nitrogen (N):
- Oxygen (O):

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F. Drawing Lewis Structures & Structural Formulas:

1. Identify the **central atom**, which is the atom with the **highest bonding capacity**. Write the symbol for the central atom than arrange the symbols for the other atoms around it.
2. Calculate the **total number of valence electrons for the molecule**. If the structure is a polyatomic ion, **add 1 electron for each negative charge and subtract one electron for each positive charge**.
3. Place 1 pair of electrons between each pair of atoms to represent the bonding electron pairs of electrons. **Each pair represents a single covalent bond**.
4. Place pairs of the remaining valence electrons as **lone pairs** on the surrounding atoms (not the central atom). Follow the duet rule for hydrogen and octet rule for all other atoms.
5. Determine how many electrons are still available by subtracting the number of electrons you have used so far from the total number of valence electrons. Place any remaining electrons on the central atom in pairs.
6. If the central atom does not have a full octet, move lone pairs from the surrounding atoms into a bonding position between those atoms and the central atom until all octets are complete.
7. **Check the finished structure**. All atoms, except hydrogen should have a complete octet, counting lone pairs and shared electrons.

- Pairs of electrons that are not involved in bonding are called:_____

Drawing Structural Formulas:

- To draw the structural formula of a molecule from a Lewis structure, r**emove the dots representing the lone pairs**. Replace the dots representing the **shared electrons** with **solid lines** to represent covalent bonds. Use double or triple lines for double or triple bonds.

Draw the Lewis Structure and structural formula for H_2CO:

Draw the Lewis structure and structural formula for the following:

- NBr_3

- CF_4

- C_2H_4

G. Drawing Lewis Structures for Polyatomic Ions:

The rules for drawing Lewis structures of polyatomic ions are the same as for molecular elements and compounds, except for the following:

- When calculating the **total number of valence electrons for the molecule**. If the structure is a polyatomic ion, **add 1 electron for each negative charge and subtract one electron for each positive charge**.
- When you have drawn the complete Lewis structure, or structural formula, place **square brackets** around the drawing and **indicate the charge** of the ion as a superscript.

Draw the Lewis structures and structural formulas for the following polyatomic ions:

- NO_3^-

- PO_3^{3-}

- CN^-

- NO_2^-

H. Exceptions to the octet rule:

- Carbon, Nitrogen, Oxygen and Fluorine atoms always obey the octet rule.
- There are some exceptions to the octet rule. Certain elements are able to form compounds in which the central atom has less than a full octet.
- Other elements are able to form compounds with more than a full octet.

Examples:

- Boron Trifluoride (BF_3) forms a molecule in which the boron atom has less than 8 valence electrons.
- Sulfur hexafluoride (SF_6) forms a molecule in which the sulfur atom has more than 8 valence electrons.

Draw the Lewis structures and structural formulas for BF_3 and SF_6